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LARCH CASEBEARER AND OTHER FACTORS INVOLVED WITH DETERIORATION OF WESTERN LARCH STANDS IN NORTHERN IDAHO

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ABSTRACT

In northern Idaho, dead and dying trees were found in stands of western larch that had been defoliated severely by larch casebearer during periods ranging from 4 to 10 years. Annual radial growth had decreased to 0.1 mm. in many trees. Examinations were made to determine the extent that larch casebearer and other factors contributed to this deterioration. Beetles were found in 11 of the 72 trees sampled. Western larch borer was collected from nine trees and scavenger beetles from the other two. The borer was abundant enough in only six trees to be a factor in causing mortality. Root rot was detected in 14 of the 72 trees and could have contributed to the death of several. Tree deterioration showed no correlation with soil series or fertility. This study did not confirm that larch casebearer was the sole cause of tree mortality; however, larch casebearer is definitely responsible for weakening and predisposing western larch stands to mortality.

INTRODUCTION

Many stands of western larch *(Larix occidentalis* Nutt.), in northern Idaho have been severely defoliated by larch casebearer *(Coleophora laricella* (Hübner)) for periods ranging from 4 to 10 years; these stands contain dead and dying trees.

Several entomologists, including Craighead[1] and Dowden[2] consider larch casebearer a tree killer. However, Webb's[3] studies suggest that although the casebearer may contribute to host tree mortality, it is seldom wholly responsible. These observations were made in the eastern United States on eastern larch *(Larix laricina* (Du Roi) K. Koch).

Denton[4] showed initial results of repeated defoliation on radial increment. Prior to casebearer damage, larch trees near St. Maries, Idaho, added 4.0 mm. radial increment in 1956; severe defoliation has occurred since 1957. When measurements were made in 1962 radial increment had decreased to 1.0 mm., representing a 75 percent reduction in growth for the 5-year period. During this same period, annual growth of nondefoliated larch trees decreased from 4.4 to 3.4 mm., or a reduction of 23 percent.

The hypothesis is that repeated severe larch casebearer defoliation can cause serious deterioration and mortality of larch stands. The objective of this study was to determine the validity of this hypothesis and the extent that other factors in association with larch casebearer contribute to deterioration.

METHODS

Three sites in each of two study areas were sampled. The first study area was located in the headwaters of Marble Creek, St. Joe National Forest, Idaho. This drainage has been severely defoliated by larch casebearer since 1962, and larch stands contain the greatest amount of host tree deterioration (figure 1) of any in this region; many trees in these stands were already dead. The second study area was about 125 air miles further north, near Falls, Idaho, in the Kaniksu National Forest. Severe casebearer feeding has occurred here since 1963, but only a few trees have died. Tip killing is confined mostly to the outer 25 percent of the branch length.

At each of the six sites, 10 sample trees (total, 60 trees) that showed various degrees of die-back and two "check" trees (with little or no die-back on branch tips) were uprooted by a bulldozer to permit detailed examination. Altogether 36 trees were sampled in each of the two study areas.

The roots, bole, and foliage of each sample tree were examined for factors that could have contributed to its deterioration. Insect and disease specimens present on sample trees were collected for identification. Increment cores were taken near the root collar of each tree and used to prepare cultures of any existing pathogens (figure 2). Diameter, tree height, crown class, and degree of damage were determined for each sample tree. The damage categories were assigned as follows:

Sparse--Die-back just beginning, or up to 25 percent of the branch length dead (majority of branches).

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[1]F. C. Craighead. Insect enemies of eastern forests. U.S. Dep. Agr. Misc. Pub. 657, 490 p. 1950.

[2]P. B. Dowden. Biological control of forest insects in the United States and Canada. J. Forestry 55:723-726. 1957.

[3]F. E. Webb. An ecological study of the larch casebearer. Diss. Abstr. 13(5). Ann Arbor, Mich. Univ. Microfilm. 1953.

[4]R. E. Denton. The larch casebearer in western larch forests, Northern Rocky Mountain Region; a problem analysis. Unpub. rep. filed at Intermountain Forest & Range Exp. Sta., USDA Forest Service, Ogden, Utah. 1964.

Figure 1.--Stand of deteriorating western larch severely defoliated during a 5-year period by larch casebearer in the Marble Creek drainage. Only the upper third of the crown is alive on the tree in background.

Medium--From 25 to 85 percent of the branch length dead.

Severe--Foliage remaining only on the inner 15 percent of the branch length, or epicormic branchlets apparent, or all branches dead except the upper one-fourth of the crown.

Dead--No foliage.

Soil conditions and type were recorded at each site. Examinations of Marble Creek soils were made during August 21 to 25, and of Falls soils during October 16 to 18, 1967.

Checking Radial Growth Rates

A disc was cut at breast height from each sample tree to measure annual radial growth. Two radii were arbitrarily chosen for measurement on each disc after the surfaces were sanded. Annual radial increments were measured to the nearest 0.1 mm. for the period 1958-1967, using a De Rouen[5] increment measurer.

Increment measurements of 10 trees were averaged to calculate the annual growth rates for each site. It was obvious that little difference existed in growth rates between sites in an area; therefore, data for 30 trees at Falls were combined, and data for 30 trees at Marble Creek were combined to arrive at a single set of curves for each area (figures 3 and 4). The values were plotted on semilogarithmic paper to emphasize any major departures from the established growth rates of the trees prior to infestation by larch casebearer.

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[5]Mention of trade names does not imply endorsement by USDA Forest Service.

Figure 2.--Removing increment core from root collar of western larch to culture pathogens. Note that roots have been exposed for examination.

In each area, two increment cores were taken at breast height from each of 10 western white pines *(Pinus monticola* Dougl.) to determine if their growth rates were affected during the same period (1958-1967).

RESULTS

The diameters at breast height on the 72 sample larch trees ranged from 3.0 to 11.1 inches, and heights ranged from 15 to 45 feet. Only one tree was classed as suppressed. Damage varied from slight die-back on the branch tips to dead trees. Insects other than larch casebearer were found only on dead trees except for one moderately damaged tree (table 1).

Relationship Between Insects and Damage

Larch casebearer was the only defoliator present on the larch trees sampled; however, larch borer and scavenger beetles were found in 11 of the 72 trees (table 1). Western larch borer *(Tetropium velutinum* LeConte) larvae were collected from nine trees; scavenger beetles from the other two. Ross[6] reported that western larch borer may cause death of *Larix* but indicated that it might be more important as a wood borer than as a tree killer. Western larch borer was estimated to be abundant enough in only six of the nine trees to be considered a factor in causing tree mortality.

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[6]D. A. Ross. The western larch borer, *Tetropium velutinum* Le Conte, in interior British Columbia. J. Entomol. Soc. Brit. Columbia 64:25-28. 1967.

Table 1.--Examination of western larch trees heavily infested with larch casebearer larvae with

Area	Tree number	Site 1 d.b.h.	Tree height	Crown class	Damage class	Insects other than casebearer	Culture results[1]	d.b.h.	Tree height	Crow
		Inches	Feet					Inches	Feet	
Marble Creek	1	5.3	35	Intermediate	Dead	Few T.v.[2]	A.m.	7.2	32	Open
	2	7.1	40	Intermediate	Severe	--	N	6.5	35	Codo
	3	6.9	35	Codominant	Severe	--	Y	3.5	22	Codo
	4	7.3	40	Codominant	Severe	--	Y	7.4	35	Open
	5	5.0	32	Codominant	Severe	--	Y	4.8	25	Open
	6	7.2	40	Codominant	Medium	--	N	5.5	25	Open
	7	3.7	22	Intermediate	Dead	Few secondaries	A.m.	8.8	32	Open
	8	6.9	33	Intermediate	Severe	--	B	6.0	30	Inte
	9	3.5	20	Intermediate	Dead	Few secondaries	A.m.	6.9	35	Codo
	10	5.1	22	Intermediate	Medium	--	A.m.	4.4	30	Codo
	11	8.1	45	Codominant	Sparse	--	B	6.5	40	Open
	12	10.6	45	Dominant	None	--	Y	8.5	42	Domi
Falls	1	4.0	17	Dominant	Medium	--	N	5.0	18	Codo
	2	3.0	15	Dominant	Sparse	--	N	8.0	30	Domi
	3	5.0	35	Dominant	Medium	--	A.m.	4.5	25	Domi
	4	8.0	36	Dominant	Sparse	--	N	3.5	22	Dom
	5	6.0	35	Dominant	Sparse	--	N	3.0	22	Dom
	6	6.0	24	Dominant	Sparse	--	B	5.0	28	Dom
	7	3.0	20	Intermediate	Medium	--	B	6.0	28	Int
	8	7.0	30	Codominant	Sparse	--	A.m.	9.0	42	Dom
	9	6.0	35	Suppressed	Sparse	--	N	3.5	22	Int
	10	7.0	38	Intermediate	Medium	--	Y	4.0	20	Dom
	11	6.0	30	Dominant	None	--	Y	3.0	20	Int
	12	9.0	35	Dominant	None	--	N	4.5	30	Dom

[1] A.m. = *Armillaria mellea*; B = bacteria; Y = yeast; N = no growth.
[2] T.v. = The western larch borer, *Tetropium velutinum* Lec. Specimens were identified by Dr. D.

the headwaters of Marble Creek, and near Falls, Idaho, to determine cause of deterioration.

	Site 2						Site 3		
:lass	Damage class	Insects other than casebearer	Culture results	d.b.h.	Tree height	Crown class	Damage class	Insects other than casebearer	Culture results
				Inches	Feet				
:own	Sparse	--	N	6.0	22	Open grown	Dead	T.v. in collar	Y
ıant	Medium	--	N	8.0	35	Open grown	Dead	T.v. in collar	Y
ıant	Dead	Few T.v.	A.m.	9.0	35	Open grown	Medium	--	B
:own	Medium	--	Y	11.1	40	Open grown	Severe	--	Y
:own	Severe	--	A.m.	8.4	32	Open grown	Medium	--	Y
rown	Dead	Many T.v.	A.m.	5.5	20	Open grown	Severe	--	A.m.
rown	Sparse	--	N	6.9	28	Open grown	Severe	--	N
ediate	Dead	Few T.v.	Y	8.6	35	Open grown	Dead	Many T.v.	N
ıant	Sparse	--	B	5.6	25	Open grown	Severe	--	N
ıant	Dead	T.v. had emerged	A.m.	7.2	35	Dominant	Severe	--	N
rown	Sparse	--	N	10.0	40	Open grown	None	--	Y
ıt	None	--	N	6.4	27	Open grown	None	--	N
ıant	Medium	--	A.m.	3.5	21	Intermediate	Severe	--	A.m.
ıt	Sparse	--	N	4.0	22	Intermediate	Medium	--	B
ıt	Medium	--	N	4.5	30	Dominant	Sparse	--	B
ıt	Sparse	--	N	4.0	35	Intermediate	Severe	--	N
ıt	Medium	--	N	3.0	16	Dominant	Severe	--	N
ıt	Sparse	--	N	3.5	26	Dominant	Medium	Many T.v.	N
ediate	Sparse	--	Y	4.0	25	Codominant	Severe	--	N
ıt	Sparse	--	B	3.0	20	Codominant	Severe	--	N
ediate	Sparse	--	N	7.0	40	Dominant	Sparse	--	N
ıt	Severe	--	A.m.	4.0	22	Dominant	Sparse	--	Y
ediate	None	--	N	3.0	22	Intermediate	None	--	N
ıt	None	--	N	7.0	38	Dominant	None	--	N

Ross, Forest Entomology Laboratory, Vernon, B.C., Canada.

Table 1.--Examination of western larch trees heavily infested with larch casebearer larvae within the headwaters of Marble Creek, and near Falls, Idaho, to determine cause of deterioration.

Area	Tree number	Site 1 d.b.h.	Site 1 Tree height	Site 1 Crown class	Site 1 Damage class	Site 1 Insects other than casebearer	Site 1 Culture results[1]	Site 2 d.b.h.	Site 2 Tree height	Site 2 Crown class	Site 2 Damage class	Site 2 Insects other than casebearer	Site 2 Culture results	Site 3 d.b.h.	Site 3 Tree height	Site 3 Crown class	Site 3 Damage class	Site 3 Insects other than casebearer	Site 3 Culture results
		Inches	Feet					Inches	Feet					Inches	Feet				
Marble Creek	1	5.3	35	Intermediate	Dead	Few T.v.[2]	A.m.	7.2	32	Open grown	Sparse	--	N	6.0	22	Open grown	Dead	T.v. in collar	Y
	2	7.1	40	Intermediate	Severe	--	N	6.5	35	Codominant	Medium	--	N	8.0	35	Open grown	Dead	T.v. in collar	Y
	3	6.9	35	Codominant	Severe	--	Y	3.5	22	Codominant	Dead	Few T.v.	A.m.	9.0	35	Open grown	Medium	--	B
	4	7.3	40	Codominant	Severe	--	Y	7.4	35	Open grown	Medium	--	Y	11.1	40	Open grown	Severe	--	Y
	5	5.0	32	Codominant	Severe	--	Y	4.8	25	Open grown	Severe	--	A.m.	8.4	32	Open grown	Medium	--	Y
	6	7.2	40	Codominant	Medium	--	N	5.5	25	Open grown	Dead	Many T.v.	A.m.	5.5	20	Open grown	Severe	--	A.m.
	7	3.7	22	Intermediate	Dead	Few secondaries	A.m.	8.8	32	Open grown	Sparse	--	N	6.9	28	Open grown	Severe	--	N
	8	6.9	33	Intermediate	Severe	--	B	6.0	30	Intermediate	Dead	Few T.v.	Y	8.6	35	Open grown	Dead	Many T.v.	N
	9	3.5	20	Intermediate	Dead	Few secondaries	A.m.	6.9	35	Codominant	Sparse	--	B	5.6	25	Open grown	Severe	--	N
	10	5.1	22	Intermediate	Medium	--	A.m.	4.4	30	Codominant	Dead	T.v. had emerged	A.m.	7.2	35	Dominant	Severe	--	N
	11	8.1	45	Codominant	Sparse	--	B	6.5	40	Open grown	Sparse	--	N	10.0	40	Open grown	None	--	Y
	12	10.6	45	Dominant	None	--	Y	8.5	42	Dominant	None	--	N	6.4	27	Open grown	None	--	N
Falls	1	4.0	17	Dominant	Medium	--	N	5.0	18	Codominant	Medium	--	A.m.	3.5	21	Intermediate	Severe	--	A.m.
	2	3.0	15	Dominant	Sparse	--	N	8.0	30	Dominant	Sparse	--	N	4.0	22	Intermediate	Medium	--	B
	3	5.0	35	Dominant	Medium	--	A.m.	4.5	25	Dominant	Medium	--	N	4.5	30	Dominant	Sparse	--	B
	4	8.0	36	Dominant	Sparse	--	N	3.5	22	Dominant	Sparse	--	N	4.0	35	Intermediate	Severe	--	N
	5	6.0	35	Dominant	Sparse	--	N	3.0	22	Dominant	Medium	--	N	3.0	16	Dominant	Severe	--	N
	6	6.0	24	Dominant	Sparse	--	B	5.0	28	Dominant	Sparse	--	N	3.5	26	Dominant	Medium	Many T.v.	N
	7	3.0	20	Intermediate	Medium	--	B	6.0	28	Intermediate	Sparse	--	Y	4.0	25	Codominant	Severe	--	N
	8	7.0	30	Codominant	Sparse	--	A.m.	9.0	42	Dominant	Sparse	--	B	3.0	20	Codominant	Severe	--	N
	9	6.0	35	Suppressed	Sparse	--	N	3.5	22	Intermediate	Sparse	--	N	7.0	40	Dominant	Sparse	--	N
	10	7.0	38	Intermediate	Medium	--	Y	4.0	20	Dominant	Severe	--	A.m.	4.0	22	Dominant	Sparse	--	Y
	11	6.0	30	Dominant	None	--	Y	3.0	20	Intermediate	None	--	N	3.0	22	Intermediate	None	--	N
	12	9.0	35	Dominant	None	--	N	4.5	30	Dominant	None	--	N	7.0	38	Dominant	None	--	N

[1]A.m. = *Armillaria mellea*; B = bacteria; Y = yeast; N = no growth.
[2]T.v. = The western larch borer, *Tetropium velutinum* Lec. Specimens were identified by Dr. D. A. Ross, Forest Entomology Laboratory, Vernon, B.C., Canada.

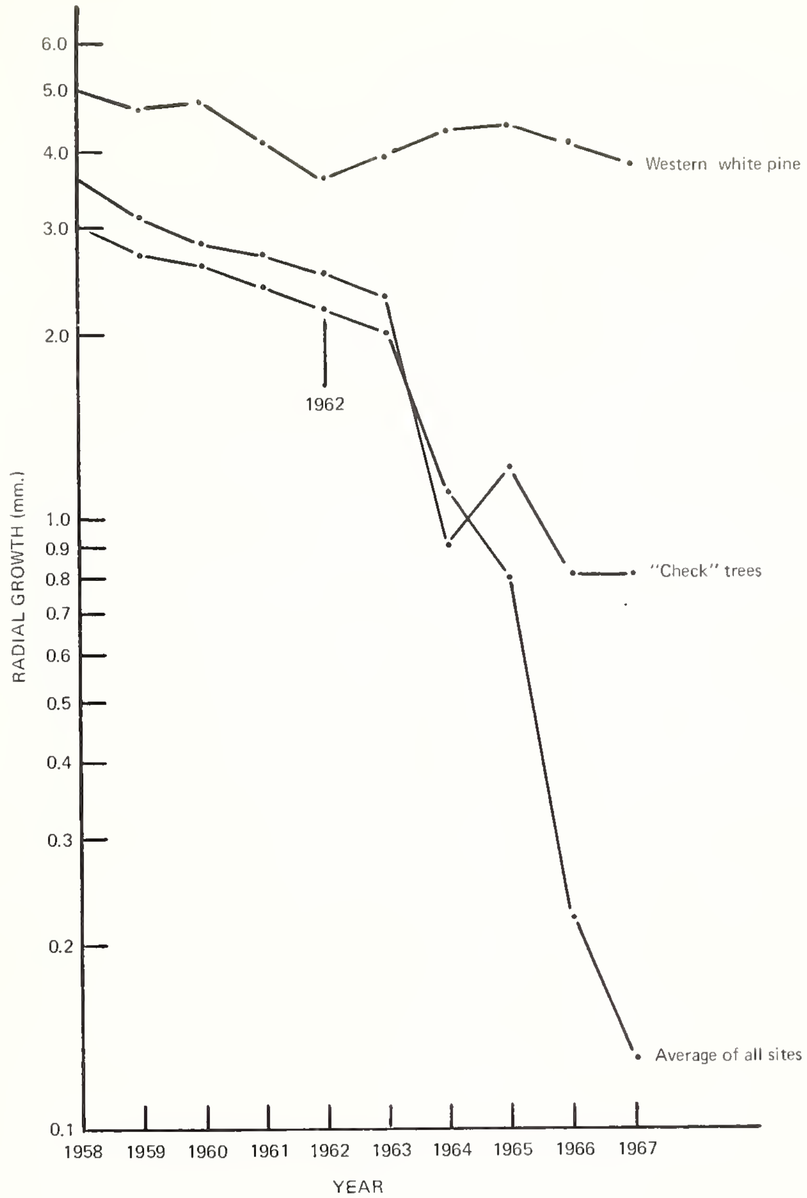
Figure 3.--Graph comparing radial growth increments of defoliated western larch and western white pine species at Falls, Idaho.

The question arises, "If the larch casebearer had been eliminated from these larch trees when they were weakened to the point where growth practically stopped, would they have recovered in the absence of western larch borer?" If so, the western larch borer might be considered a definite factor in tree mortality. If the trees could not have recovered, *T. velutinum* would be classified only as a secondary causal agent.

Relationship Between Diseases and Damage

Armillaria mellea (Vahl.) Quel. was cultured from each of 12 trees in which root-rot was visible and in two others that were apparently rot free. Four of these 14 trees were infested with *T. velutinum*, which would have probably killed them in the absence of root rot. From a total of 48 cultures, 15 produced a yeast, 9 bacteria, and 34 showed no pathogens (table 1). No attempt was made to identify the yeast and bacteria. *A. mellea* is known to be a parasitic disease and could have been a major factor in the death of the trees on which it was found. The bacteria and yeast probably are normal components within the physiological system of the tree and exist in a beneficial relationship with the tree; they very likely do not cause damage to the larch.

Figure 4.--Graph comparing radial growth increments of defoliated western larch and western white pine species from Marble Creek.



Effect of Repeated Defoliation on Radial Growth

Radial increment measurements of 10 trees for each of three sites (total, 30 trees) in the two study areas are summarized in tables 2 and 3. Data for the three sites in each study area were combined, and the resulting curves for each area are plotted graphically in figures 3 and 4.

The two infested trees selected as "check" trees at each site showed practically no evidence of die-back; however, increment measurements revealed that radial growth had been sharply curtailed, even though crown deterioration hadn't progressed to the same degree as the other trees sampled. Thus, because these trees were infested they cannot be considered as true "check" trees.

In the Falls area, growth increments of sample western larch decreased from 3.6 mm. in 1963 to 0.3 mm. in 1967--this amounts to a 92 percent reduction in the 4-year period of severe larch casebearer defoliation. During this same period, western white pine showed an increase in radial increment (figure 3).

Table 2.--Average radial increment per plot--Marble Creek

Site	Radial growth (in mm.)									
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Site 1	2.7	2.3	2.3	2.0	2.0	2.0	1.5	1.5	0.24	0.13
Site 2	2.8	2.4	2.6	2.4	1.9	1.3	1.0	.6	.20	.12
Site 3	3.5	3.3	2.9	2.7	2.8	2.6	.9	.3	.20	.14
Average sites 1, 2, 3	3.0	2.7	2.6	2.4	2.2	2.0	1.1	.8	.22	.13
Average check trees	3.6	3.1	2.8	2.7	2.5	2.3	.9	1.2	.80	.80
Average western white pine	5.1	4.7	4.8	4.1	3.6	3.9	4.3	4.4	4.10	3.80

In Marble Creek, growth increments of living western larch sample trees decreased from 2.2 mm in 1962 to slightly more than 0.1 mm in 1967--a 94 percent reduction in the 5-year period of severe defoliation. As in the Falls area, western white pine showed an overall increase in radial increment during the same period (figure 4).

Relationship Between Soil Types and Damage

Soils at each sampling site were examined, described, and samples collected to determine organic matter, P, K, Ca, Mg, and Ph.

The soils at Marble Creek and Falls have several common characteristics (table 4):

1. They are capped with loess (wind-deposited silt) varying in depth from 9 to 24 inches;
2. The soils are deep--5 feet or more;
3. The soil profiles are relatively free of rock--less than 15 percent throughout;
4. Soil textures of all horizons are a silt loam.

Differences: Soils in the Marble Creek area are developed in meta-sediments associated with the Belt series that are highly weathered and fractured, while the soils at Falls are developed in thick lacustrine deposits, consisting of silt, deposited in varves. Soil test data indicate that the soil at Falls is more fertile than the soil at Marble Creek. This does not necessarily mean that it is more productive, since other factors such as climate, physical properties of the soil, and management practices may offset the fertility advantage. The Falls soil has a very hard or indurated layer at 16 inches that restricts rooting depth and may reduce tree growth. However, this layer also limits leaching of nutrients.

Table 3.--Average radial increment per plot--Falls, Idaho

Site	Radial growth (in mm.)									
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Site 1	4.0	4.1	4.0	3.7	3.7	4.4	3.6	2.5	0.8	0.3
Site 2	3.3	3.2	3.2	2.8	3.0	3.6	4.1	3.5	.7	.5
Site 3	2.0	2.3	2.4	2.4	2.5	2.7	3.0	2.6	.6	.2
Average sites 1, 2, 3	3.1	3.2	3.2	3.0	3.1	3.6	3.6	2.9	.7	.3
Average check trees	3.5	3.5	3.7	3.5	3.5	4.1	4.1	3.2	1.4	.5
Average western white pine	4.3	4.6	4.4	4.4	4.4	4.3	5.1	4.6	4.7	4.7

Table 4.--Chemical and physical properties of the soils in the Marble Creek and Falls, Idaho, study areas

Sampling depth	Horizon	pH	Cond.	Organic matter	Avail. P	Avail. K	Ca	Mg	Texture
Inches				Percent	Lbs./acre				
	MARBLE CREEK								
5-10	B2ir	7.0	0	2.80 low	186 high	170 low	292	88.8	silt
15-17	B2	6.4	0	.60 v. low	134 med.	170 low	1,096	129.6	silt
26	II A2-B2	6.3	0	.20 v. low	18 v. low	170 low	2,108	187.2	silt
54	II C	5.9	0	.07 v. low	20 v. low	270 med.	3,068	249.6	silt
	FALLS Site 1								
0-19	B2ir	--	-	--	--	--	--	--	--
19-25	II A21	6.9	0	0.30	122 med.	390 med.	800	238.0	silt
25-30	II A22-$B22_1$	6.7	0	.30	222 high	330 med.	756	242.0	silt
34	II A23-$B22_2$	6.6	0	.40	102 med.	240 low	1,316	166.0	silt
	FALLS Site 3								
0-9	B2ir	7.0	0	2.30 low	480 high	400 med.	892	112.0	silt
9-16	II A21	6.9	0	.10 v. low	44 v. low	280 med.	724	299.0	silt
16-21	II A22-$B21_x$	6.3	0	.20 v. low	62 low	250 med.	1,784	184.0	silt
21-30	II A23-$B22_x$	6.1	0	.20 v. low	78 low	210 med.	796	256.0	silt
40	II A24-$B23_x$	6.1	0	.20 v. low	80 low	170 low	2,072	173.0	silt

When these two soils are compared to fertility standards established by Wilde[7] for forest soils, the surface horizon receives a rating of Grade A for all elements, except K in the Marble Creek soil, which is Grade B. Subsoil fertility of the Marble Creek soil is Grade C for available P and K, while at Falls it is Grade B. Fertility standards are shown in the following tabulation:

Wilde--Forest soil fertility rating

	pH	Available P (Lbs./acre)	Available K (Lbs./acre)
Grade A	5.5-7.3	100	250
Grade B	5.0-6.0	70	200
Grade C	4.8-5.5	25	100

It was believed earlier that deep, loamy, fertile soils would produce more vigorous trees which would thereby be more tolerant of casebearer damage than trees grown on marginal soils. However, there appears to be no correlation between severity of infestation or tree mortality and soil productivity because infestation and tree damage are nearly the same for both Falls and Marble Creek.

[7] S. A. Wilde. Forest Soils. New York, The Ronald Press Co. 360 p. 1958.

DISCUSSION

It is evident that die-back and branch killing in western larch stands are the result of repeated severe defoliation by larch casebearer. These conditions appeared after the third or fourth year of continuous heavy feeding. Whether this defoliation has caused the actual death of trees has not been confirmed. After trees have become weakened or reach the advanced state of deterioration such as the ones shown in figure 1, they are susceptible to invasion by secondary agents. Wood borers and root rots are common killers of weakened trees and evidence of these destructive agents was found in most of the dead trees examined during this study. These data do not show at what stage of deterioration the sample trees were invaded by borers or rots. Most of the moderately to severely damaged trees did not contain these destructive secondaries. Therefore, it is obvious that badly weakened trees may die without the presence of wood borers or rots; if this happens, larch casebearer has to be considered the cause of death.

Tree deterioration could not be correlated with site factors such as soil moisture or soil fertility. While radial increment of larch trees decreased during the last 4- to 5-year period within the two sample areas, increment increased on neighboring western white pine trees. If there was a lack of soil moisture, the white pines would have put on less growth. Soils at Falls and Marble Creek are capable of growing vigorous larch trees; furthermore, there are no obvious physical or chemical soil properties that create unhealthy conditions for larch trees. Again, larch casebearer which is common to both areas seems to be the only factor that could be responsible for this deterioration.

Aerial surveys in May 1968 revealed deterioration within thousands of acres of western larch on the Kaniksu, Coeur d'Alene, and St. Joe National Forests in northern Idaho. Observations indicated that the degree of deterioration had no correlation with growing sites, stand density, aspect, or stand composition. Deterioration was as severe under one set of conditions as another.

Studies are planned to accomplish the following: measure the rate of deterioration from year to year; determine whether stand density is a factor; compare growth rates between defoliated and nondefoliated larch stands; and determine any other factors that might be of importance.

The implication is clear that larch casebearer is responsible for weakening and predisposing western larch stands to mortality. Due to the destructiveness of larch casebearer, plans and finances are justified to determine feasible control methods and to curtail the impending destruction of a valuable timber species.

TUNNOCK SCOTT, DENTON ROBERT E., CARLSON CLINTON E., and JANSSEN WILLIS W.

1969. Larch casebearer and other factors involved with deterioration of western larch stands in northern Idaho, USDA Forest Serv. Res. Pap. INT-68, 10 p., illus.

In northern Idaho, dead and dying trees were found in western larch stands defoliated severely by larch casebearer during periods ranging from 4 to 10 years. Annual radial growth has decreased to 0.1 mm. in many trees. Examinations determined the extent that larch casebearer and other factors contributed to the deterioration. Of the 72 trees sampled, beetles were found in 11. Results clearly implied that larch casebearer is definitely responsible for weakening and predisposing western larch stands to mortality.

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ABOUT THE FOREST SERVICE . . .

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- Conducting forest and range research at over 75 locations ranging from Puerto Rico to Alaska to Hawaii.
- Participating with all State Forestry agencies in cooperative programs to protect, improve, and wisely use our Country's 395 million acres of State, local, and private forest lands.
- Managing and protecting the 187-million acre National Forest System.

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